Chapter 2
Related Work

Abstract In this chapter we present related work in the scientific area of mobile learning and we also investigate current research efforts in the area of affective mobile computing. Furthermore, we give a brief overview of past works and approaches that have been based on Object-Oriented programming. As one may observe, mobile-learning, in its modern concept, traces its roots to the first decade of 2000. More specifically, a small number of mobile learning applications were built during the first half of the decade with a very high scientific and social interest in this area. Vincent (2009) states that over one half of the world's population is expected to be using mobile phones by 2009 and many people have become attached to and even dependent on mobile devices. In the same study mobile phones are found to maintain close ties within peoples' families and friends. As expected, during the last 5 years there has been a continuously increasing development, using modern technology, both in mobile software and hardware driven mostly by economic benefits.

2.1 Mobile Learning

Computer Assisted Learning (CAL) has grown enormously during the past decades and has been enhanced by the recent advances in web-based applications, multimedia technology, intelligent systems and software engineering. CAL may be used by instructors in a complementary way for their courses. Students may use educational software inside and outside classrooms in order to learn, practice and consolidate their knowledge. They may also use software from remote places in cases where the instructor is far from the student. The quite recent area of Mobile Assisted Language Learning (MALL) has made its appearance during the last decade and is currently widely used to assist in language learning (Virvou et al. 2011). MALL has evolved to support students' language learning with the increased use of mobile technologies such as mobile phones, mobile music players, PDAs and mobile smartphone devices.

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However, many researchers (Salomon 1990; Welch and Brownell 2000) point out that technology is effective when developers thoughtfully consider the merit and limitations of a particular application while employing effective pedagogical practices to achieve a specific objective. For example, (Hasebrook and Gremm 1999) argue that learning gains are mainly due to instructional methods and thus many researchers aim at making their tutoring systems more effective using "intelligent" software technologies to adapt to the learners' demands, abilities and knowledge. The same applies to web-based educational applications, which are often limited to the capabilities of "electronic books" with little scope for interactivity with the student.

Intelligence can be added to educational software if ITSs technology is used. ITSs have been designed to individualise the educational experience of students according to their level of knowledge and skill (Du Boulay 2000). It has been widely agreed that an ITS should consist of four components, namely the domain knowledge, the student modelling component, the tutoring component and the user interface (Self 1999; Wenger 1987). The domain knowledge consists of a representation of the domain to be taught (e.g. Biology, Chemistry, etc.). The student modeling component involves the construction of a qualitative representation that accounts for student behavior in terms of existing background knowledge about the domain and about students learning the domain (Sison and Shimura 1998). Student modeling may model various aspects of a student, such as what his/her knowledge level is in the domain being taught (e.g. (Sison and Shimura 1998)), whether s/he has misconceptions (e.g. in previous research of our own (Virvou 2002; Virvou and Kabassi 2001)), what the associated emotions with the process of learning are (Elliott et al. 1999) etc. The tutoring component contains a representation of the teaching strategies of the system. Finally the user interface is responsible for translating between the system's internal representation and an interface language understandable by the student.

However the development of such educational programs is a hard task that needs quite a lot of effort from domain and computer experts. One solution to this problem is given by ITS authoring tools, which provide user-friendly environments for human instructors to develop their own ITSs in an easy way. Naturally, the reasoning abilities of the resulting ITSs have to be provided by the authoring tools. Therefore the authoring tools incorporate generic and domain-independent methods that can be customized to the particular tutoring domain of each instructor-author. In this sense authoring tools are harder to develop than ITSs but they provide a high degree of reusability. Therefore they are worth the extra effort.

There have been many research efforts to transfer the technology of ITSs and authoring tools over the Internet. A review (Brusilovsky and Peylo 2003) has shown that all well-known technologies from the areas of ITS have already been re-implemented for the Web. This could be expected since Web-based education needs intelligence to a greater extent than standalone applications. There are two important reasons for this: First, most Web-based educational applications are targeted to a much wider variety of users than any standalone application and thus there is a need for greater personalization; second, students usually work with Web-based educational systems on their own (often from home) and cannot benefit from personalized assistance that an instructor or a peer student can provide in the normal classroom settings (Weber and Brusilovski 2001).

Web-based ITSs and ITS authoring tools can be enhanced significantly by incorporating mobile features in them. Many researchers point out that the basic approach to mobile education should be integrative, combining a variety of devices (mobile and non-mobile) via a variety of transmitting techniques (wired and wireless) (Lehner and Nosekabel 2002; Farooq et al. 2002). There have been quite a lot of primary attempts to incorporate mobile features to this kind of educational technology and the results so far confirm the great potential of this incorporation. As an example, (Uzunboylu et al. 2009) investigated the use of integrating use of mobile technologies, data services, and multimedia messaging systems to increase students' use of mobile technologies and to develop environmental awareness. Data was collected using "usefulness of mobile learning systems" questionnaire from a sample consisting of students.

In particular, Ketamo (2003) reports on an adaptive geometry game for handheld devices that is based on student modeling. Ketamo admits that the system developed was very limited and the observed behavior was defined as very simple. However, an evaluation study that was conducted concerning this system showed that the learning effect was very promising with the handheld platform. A quite different approach is described in the system called KleOS (Vavoula and Sharples 2002) which allows users to organize and manage their learning experiences and resources as a visual timeline. The architecture of KleOS allows it to be used on a number of different platforms including handheld devices. However, unlike Mobile Author, none of the above systems deals with the problem of facilitating the human instructor in the educational software development and maintenance. This problem is dealt with to a certain extent by Moulin et al. (2002). The educational software they have built has addressed both the edition of a mobile lesson content and the management of the students in the field. However, their approach depended heavily on geo-referenced data. Therefore, it was beyond the scope of that system to achieve domain-independence and sufficient generality for the creation of an authoring tool that could provide an environment to instructors for them to create an ITS in any domain they are interested in.

Moving on more recent works considering mobile learning, in (Zhan and Deng 2010) the authors designed a portable multiple-channel message servicing technology for educational reasons where the responding speed and service quality were greatly improved. Chen and Gao (2009) expatiate concepts of mobile learning, realization technology of mobile learning and mobile learning model based on 3G technology and provides four models of mobile learning. The authors of (De Sa and Carrico 2009) present a framework which supports end-users while creating their customized tools for their students. Additionally, the framework comprises means for teachers to include persuasive and motivational mechanisms and hints, promoting student engagement while pursuing their learning activities. The authors describe the framework's architecture, its features, including the supporting guidelines and development process, and detail some of the already developed material and the results that emerged during initial trials and case studies, also stressing their contributions to the field of m-learning.

An interesting review (Frohberg et al. 2009) uses a Mobile Learning framework to evaluate and categorize 102 Mobile Learning projects, and to briefly introduce exemplary projects for each category. All projects were analyzed with the criteria: context, tools, control, communication, subject and objective. Although a significant number of projects have ventured to incorporate the physical context into the learning experience, few projects include a socializing context. Although few projects explicitly discuss the Mobile Learning control issues, one can find all approaches from pure teacher control to learner control. Despite the fact that mobile phones initially started as a communication device, communication and collaboration play a surprisingly small role in Mobile Learning projects. Most Mobile Learning projects support novices, although one might argue that the largest potential is supporting. The authors of (Cavus and Uzunboylu 2009) investigate the effect of mobile learning over the critical thinking skills. The students' critical thinking disposition and the usefulness of mobile learning systems (UMLS) were evaluated. Overall, students' attitudes toward the usefulness of a mobile learning system improved at the end of the experimental study. It was found that after the study, the students' creativity improved significantly. Furthermore, researchers found that outdoor experiences influenced students' attitudes positively. Additionally, results indicate that in this study, working collaboratively and sharing information were built into a group activity.

In the scientific literature of mobile authoring, the authors of (Kuo and Huang 2009) propose an authoring tool named Mobile E-learning Authoring Tool (MEAT) to produce adaptable learning contents and test items. In addition, the visualized course organization tool has also been provided to teachers to organize their courses. All functionalities of the MEAT are designed according to the teachers' feedback and their technological learning needs. To evaluate the MEAT, the authors have conducted an extensive comparison between the MEAT and other (adaptation) content authoring tools. The results indicate that MEAT can produce adaptable contents and test items while supporting learning standard.

The work of (Motiwalla 2007) explores the extension of e-learning into wireless/handheld (W/H) computing devices with the help of a mobile learning (m-learning) framework. This framework provides the requirements to develop m-learning applications that can be used to complement classroom or distance learning. A prototype application was developed to link W/H devices to three course websites. The m-learning applications were pilot-tested for two semesters with a total of 63 students from undergraduate and graduate courses at our university. The students used the m-learning environment with a variety of W/H devices and reported their experiences through a survey and interviews at the end of the semester. The results from this exploratory study provide a better understanding on the role of mobile technology in higher education.

According to the authors of (Wang et al. 2009), acceptance of m-learning by individuals is critical to the successful implementation of m-learning systems and thus, there is a need to research the factors that affect user intention to use m-learning.

The authors investigated the determinants of m-learning acceptance and discovered if there exist either age or gender differences in the acceptance of m-learning. After having tested it, the authors indicated that performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning were all significant determinants of behavioral intention to use m-learning.

2.2 Mobile Multimodal Interaction

In the study of Motiwalla and Qin (2007), the authors explore the integration of speech or voice recognition technologies into m-learning applications. Their voice-enabled mobile application (voice recognition and text-to-speech) not only helps normal users avoid the cumbersome task of typing using small mobile keypads, but also enables people with visual and mobility disabilities to engage in online education. Finally, the results of this study may provide insights into how voice-enabled applications would be received by the blind disabled population. In Feng et al. (2011), the authors highlight the characteristics of mobile search comparing with its desktop counterpart and also provide a review in the state of art technologies of speech-based mobile search.

Current mobile on screen interaction concepts are limited to a two dimensional space with simple or multi-touch capabilities. To this point, the authors of (Hurst and Van Wezel 2011) explore different interaction approaches that rely on multimodal sensor input and aim at providing a richer, more complex, and engaging interaction experience. The authors of this study also conclude that finger tracking interaction seems to be a quite promising approach for mobile gaming and other mobile leisure applications. Spika (2010) has created a software platform based on Java technology for the service logic and XML-based description for the definition of user interfaces that supports services with flexible multimodal user interfaces. Within the fore mentioned platform three basic motion gestures are detected:

- Shaking of the device
- Tilting the device (detection of 6 device orientations)
- Tapping on the device.

The research presented in (Rico 2010) examines the factors affecting social acceptability of multimodal interactions, beginning with gesture-based interfaces. The results of this study revealed the importance of social acceptability, demonstrating that some gestures were significantly more accepted than others. Chittaro (2010) discusses some of the opportunities and challenges of mobile multimodality, which can be a key factor for a better design of mobile interfaces to help people do more on their mobile phones, requiring less time and attention. This study provides important information about interaction differences and similarities between desktop computers and mobile devices and also stresses the need for research towards the effectiveness of different modalities during multiple tasks in mobile conditions. Vainio (2009) concludes that by designing predictive clues and rhythm into mobile multimodal navigation applications, we can improve navigation aids for users. In his paper the author introduced a study that dealt with multimodal navigation and tried to utilize the design practice of episodes of motion that originates from urban planning.

Kondratova (2009) discusses issues associated with improving usability of user interactions with mobile devices in mobile learning applications. The main focus is on using speech recognition and multimodal information such as speech-based interfaces that are capable of interpreting voice commands. The results of this study indicate feasibility of incorporating speech and multimodal interaction in designing applications for mobile devices, while it is also shown that there are considerable limitations in mobile applications including social, technological and environmental factors. The authors of (Reis et al. 2008) have conducted an important study where users had to manipulate a multimodal questionnaire considering different environmental variables, such as lighting, noise, position, movement and type of content. This study investigates the effect of the different context variables in users' choices regarding the available modalities of interaction.

Another example of personalized mobile multimodal interfaces can be found in (Aoidh 2006), where the emphasis is in the personalization of the human–computer interaction with a mobile Geographic Information System (GIS). The author of this paper tries to achieve personalization in the mobile GIS through the implicit and explicit profiling of each user's multimodal, mobile experience. In their paper, Oviatt and Lunsford (2005), highlight three different directions of research that were advancing state-of-the-art mobile technology. These are:

- Development of fusion-based multimodal systems
- Modeling of multimodal communication patterns
- New approaches to adaptive processing.

The authors propose that advances in these research directions may provide more reliable, usable, and commercially promising future mobile systems.

Mueller et al. (2004) introduce an advanced generic Multimodal Interaction and Rendering System that is dedicated for mobile devices, in order to sufficiently integrate advanced multimodal interactions such as mobile speech recognition and mobile speech synthesis. The authors of Shoogle (Williamson et al. 2007) illustrate how model-based interaction can be brought into practical mobile interfaces. Their resulting interface is based around active sensing. According to Oviatt (2000) "One major goal of multimodal system design is to support more robust performance than can be achieved with a unimodal recognition technology". In this paper we may also remark that large gains in decreasing error rates were due to significant levels of mutual disambiguation in the mobile system's multimodal architecture. This study's results confirmed that a more stable multimodal architecture decreased mobile speech recognition error rate by 19–35 %. As Mantyjarvi et al. (2007) claim, Model-based approaches have been recognized as useful for managing the increasing complexity consequent to the many available interaction platforms. Accordingly, the same authors present a development tool as a solution to enable the development of tilt-based hand gesture and graphical modalities for mobile devices in a multimodal user interface.

2.3 Mobile Affective Interaction

2.3.1 Affective Interaction in Computers

Many scientists in the field of affective computing, including Picard (Picard 2003), suggest that one of the major challenges in affective computing is to try to improve the accuracy of recognizing people's emotions. During the last decade, the visual and the audio channel of human–computer interaction were considered as most important in human recognition of affective states (Cowie et al. 2001). At the same time, research in cognitive psychology and in psychophysiology produced firm evidence that affective arousal has a range of somatic and physiological correlates, such as heart rate, skin clamminess, body temperature, etc. (Cacioppo et al. 2000). Apart from verbal interactive signals (spoken words), which are person independent, nonverbal communicative signals like facial expression and vocal intonations are displayed and recognized cross culturally (Pantic and Rothkrantz 2003). A critical point towards the improvement of sophisticated emotion recognition systems is certainly the combination of multiple modalities during human–computer interaction (Caridakis et al. 2010; De Silva et al. 1997; Huang et al. 1998; Oviatt 2003; Zeng et al. 2007). Even less common modalities of interaction are currently investigated, such as in (Busso et al. 2004), where the authors associate features that are derived from the pressure distribution on a chair with affective states. However, progress in emotion recognition based on multiple modalities has been rather slow. Although several approaches have been proposed to recognize human emotions based on facial expressions or speech unimodally, relatively little work has been done in the area of general systems that can use information from multiple modalities that can be added or excluded from these systems in real time.

The problem of effectively combining data from multiple modalities also raises the question of how these modalities may be combined. Correspondingly, this problem consists of the determination of a general architecture of a multi-modal emotion recognition system, as well as of the sophisticated mechanisms that will fuse this system's available data in order to utilize the emotion recognition functions. Classification of recent affect recognizers has been made in (Liao et al. 2006) where affect recognizers have been classified into two groups on the basis of the mathematical tools that these recognizers have used: The first group using traditional classification methods in pattern recognition, including rule-based systems, discriminate analysis, fuzzy rules, case-based and instance-based learning, linear and nonlinear regression, neural networks, Bayesian learning and other learning techniques. The second group of approaches using Hidden Markov

Models, Bayesian networks etc. Indeed, a recent piece of research that uses the above approaches for the integration of audio-visual evidence is reported in (Hwang and Yoon 1981). Specifically, for person-dependent recognition, Zeng and his colleagues (Zeng et al. 2007) apply the voting method to combine the frame-based classification results from both audio and visual channels. For person-independent tests, they apply multi-stream hidden Markov models (HMM) to combine the information from multiple component streams.

In a previous work of ours (Alepis and Virvou 2009) we introduced the OO model within the architecture of a multimodal human–computer interaction system. As a next step, in (Alepis and Virvou 2010) we successfully evaluated this approach by applying it to a desktop affective e-learning application. The results were quite promising and encouraging so as to test this architecture in a more demanding domain that belongs to the very recent research area of affective mobile learning.

After a thorough investigation in the related scientific literature, we come up with the conclusions that there is a shortage of educational systems that incorporate multi-modal emotion recognition capabilities. Even less are the existing affective educational systems with mobile facilities. In (Lim and Aylett 2007) a mobile context-aware intelligent affective guide is described, that guides visitors touring an outdoor attraction. The authors of this system aim mainly at constructing a mobile guide that generates emotions. In our research, we aim at recognizing the users' emotions through their interaction with mobile devices rather than exclusively generating emotions. Another approach is found in (Yoon et al. 2007), where the authors propose a speech emotion recognition agent for mobile communication service. This system tries to recognize five emotional states, namely neutral emotional state, happiness, sadness, anger, and annoyance from the speech captured by a cellular phone in real time and then it calculates the degree of affection such as love, truthfulness, weariness, trick, and friendship. In this approach only data from the mobile device's microphone are taken into consideration, while in our research we investigate a mobile bimodal emotion recognition approach. In (Park et al. 2010), the authors propose and evaluate a new affective interaction technique to support emotional and intimate communication while speaking on the mobile phone. This new technique is called CheekTouch and uses cheeks as a medium of interaction. Tactile feedback is delivered on the cheek while people use multiple fingers as input while holding the mobile phone naturally.

2.3.2 Affective Interaction in Mobile Devices

Growing computational power of mobile devices has allowed researchers to make a step further and design applications which "feel what their user feels" (Nielek and Wierzbicki 2010). The authors of this study also state that "Emotion-aware" mobile devices followed by "emotion-aware" services and application are a natural next step in context aware researches. The authors of iFeelng (Rehman and Liu 2010) demonstrate how to turn a mobile phone into a social interface for the blind so that they can sense emotional information of others. In this study we may also find technical details on how to extract emotional information by touch input, as well as how to carry out user evaluations tests in order to test such a system's usability. Finally, the authors conclude that there are channels of communication, such as touch modality, that are not taken into careful consideration yet and which have the potential to enrich mobile phones communication among the users.

The authors of (Rehman et al. 2008) suggest that vibrotactile sensations to sight and sound can make content of mobile phones more realistic and fun. In this study the vibration of a mobile phone is used to provide emotional information. To this end, the possibilities to apply and adopt emotion measuring methods in the field of mobile HCI are investigated in (Geven et al. 2009). In Razak et al. (2008) it is stated that both voice and image are important for people to correctly recognize emotion in telecommunications. The authors of this work have used mobile phones for the interaction of users and their system requires wireless transmission of audio data.

Five emotional states, namely neutral, happiness, sadness, anger, and annoyance recognized by an agent in Cho et al. (2007) through the audio channel of interaction, using mobile phones in real time. As it is stated by the authors of this paper, the available data also contain both speaker environmental noise and network noise which degrade their system's performance in recognizing human emotions from speech. For the classification of the pre-mentioned emotional states k-NN and Fuzzy-SVM approaches have been used and the results are quite promising. Turner et al. (2008) present a survey including 184 young adults is presented in order to explore the relationships between human comfort while making and receiving mobile phone calls in different social contexts and their affective responses to public mobile phone use by others. Yoon et al. (2007) propose the construction of an emotion recognition agent for mobile communication that is based on speech data. Their system tries to recognize users' affect among five emotional states while the experimental results indicate a quite high emotional classification performance (72.5 %).

In this book our prototype systems are incorporated into an educational application and data passes through a linguistic and also a paralinguistic level of analysis in order to address affect. Furthermore, all kinds of multimodal, linguistic and paralinguistic information is stored using the OO model that supports mobile transmission of data during human-mobile device interaction. This proposal is also not found in the related scientific literature.

2.4 Object Oriented Architecture

Object-oriented programming traces its roots to the 1960s, but was not commonly used in mainstream software application development until the early 1990s. Object-oriented design provided researchers with strong frameworks to maintain

Table 2.1 Fundamental concepts in OO modelling and design

OO descriptions	
Class	Classes define abstract collections of object characteristics, including their attributes and their operations
Objects	Objects represent patterns of a class. Objects are created by classes as their templates
Instances	An instance is the actual object created at runtime (program execution)
OO operations	
Operations	Operations are defined as services that can be requested from an object to effect its behaviour. Each operation has a unique signature
Methods	Method is defined as the implementation of an operation. Methods illustrate objects' abilities. In many OO programming languages, methods are referred to as functions
Message passing	Message passing represent the general process by which an object sends data to another object or asks the other object to invoke a method. In general messages define the communication during every kind of object interaction
OO basic concepts	
Inheritance	Subclasses are more specialized versions of a class, which inherit attributes and behaviours from their parent classes, and can introduce their own
Abstraction	Abstraction is simplifying complex reality by modelling classes appropriate to the problem, and working at the most appropriate level of inheritance for a given aspect of the problem
Encapsulation	Encapsulation conceals the functional details of a class from objects that send messages to it
Polymorphism	Polymorphism allows the programmer to treat derived class members just like their parent class' members. Polymorphism in object-oriented programming is the ability of objects belonging to different data types to respond to method calls of methods of the same name, each one according to an appropriate type-specific behaviour
Decoupling	Decoupling allows for the separation of object interactions from classes and inheritance into distinct layers of abstraction
Information hiding	Information hiding represents the restriction of external access to a class's attributes
OO modelling terms	
Aggregation	Represents a relationship between two classes where one class is part of the other class
Composition	Represents a relationship like aggregation but with even "stronger" stronger. In composition a class is treated as a "whole" while another (or other classes) are its constituent "members"
Association	An association represents the way two classes are related to each other
Multiplicity	UML term that models the concepts of cardinality and optionality in an association between two classes
Stereotype (UML)	A stereotype models a common usage of a UML element
Interface	An interface represents a set of definitions of methods and values for which objects agree upon in order to cooperate with each other
Superclass	Superclass is a "mother" class from which other classes are derived
Subclass	Subclass is a "child" class that is derived from another class or classes
Override	Overriding is the action of redefining attributes and/or operations in subclasses

software quality and to develop object oriented applications in part to address common problems by emphasizing discrete, reusable units of programming logic. An object-oriented program may be considered as a collection of cooperating objects, as opposed to the conventional procedural model, in which a program is seen as a list of tasks (subroutines) to perform. In OOP, each object is capable of receiving messages, processing data, and sending messages to other objects and can be viewed as an independent mechanism with distinct roles or responsibilities.

Complementarily to the OO paradigm, the UML (Booch 1996) approach has been developed to standardize the set of notations used by most well-known object oriented concepts. In order to support models deriving by these approaches, Computer Assisted Software Engineering (CASE) tools like Rational Rose (Rational Software Corporation 1997) and Paradigm Plus (Platinum Technology 1997) have been developed.

Table 2.1 illustrates a number of fundamental concepts that are found in the strong majority of definitions of object oriented programming designs.

Object oriented approaches have been already widely used in software development environments (Shieh et al. 1996; Chin et al. 2009). An Object Oriented Learning Activity system is implemented and used to design and perform the learning activity in (Pastor et al. 2001). In (Benz et al. 2004), an object-oriented analysis is adopted for the implementation of remote sensing imagery to GIS. The authors of this paper argue that there is a large gap between theoretically available information and used information to support decision making. As a proposed strategy to bridge this gap, these authors suggest the extension of their signal processing approach for image analysis by the exploration of a hierarchical image object network to represent the strongly linked real-world objects. In these approaches the application of OO architecture has led to several minor or major advantages and has solved many problems. However, the OO approach has not been used for the development of software in the area of affective computing yet.

References

Alepis E, Virvou M (2009) Emotional intelligence in multimodal object oriented user interfaces. Stud Comput Intell 226:349–359

Alepis E, Virvou M (2010) Object oriented architecture for affective multimodal e-learning interfaces. Intell Decis Technol 4(3):171–180

Aoidh EM (2006) Personalised multimodal interfaces for mobile geographic information systems, Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 4018 LNCS, 2006, pp 452–456

Benz UC, Hofmann P, Willhauck G, Lingenfelder I, Heynen M (2004) Multi-resolution, object-oriented fuzzy analysis of remote sensing data for GIS-ready information. ISPRS J Photogrammetry Remote Sens 58(3–4):239–258

Booch G (1996) The unified modeling language. Perform Comput/Unix Rev 14(13):41–48

Brusilovsky P, Peylo C (2003) Adaptive and intelligent web-based educational systems. Int J Artif Intell Educ 13(2–4):159–172

Busso C, Deng Z, Yildirim S, Bulut M, Lee C, Kazemzadeh A, Lee S, Neu-mann U, Narayanan S (2004) Analysis of emotion recognition using facial expressions, speech and multimodal infor-mation. In: Proceedings of the 6th international conference on multimodal interfaces, ACM: State College, PA, USA

Cacioppo JT, Berntson GG, Larsen JT, Poehlmann KM, Ito TA (2000) The Psycho-physiology of emotion. In: Lewis M, Haviland-Jones JM (eds) Handbook of emotions. Guilford Press, NY, pp 173–191

Caridakis G, Karpouzis K, Wallace M, Kessous L, Amir N (2010) Multimodal user's affective state analysis in naturalistic interaction. J Multimodal User Interfaces 3(1):49–66

Cavus N, Uzunboylu H (2009) Improving critical thinking skills in mobile learning. In Procedia—Social and behavioral sciences, vol 1, Issue 1, 2009, pp 434–438

Chen Y, Gao Y (2009) Research on mobile learning based on 3G technology. In: 7th international conference on web-based learning, ICWL 2008, Jinhua, pp 33–36

Chittaro L (2010) Distinctive aspects of mobile interaction and their implications for the design of multimodal interfaces. J Multimodal User Interfaces 3(3):157–165

Cho Y-H, Park K-S, Pak RJ (2007) Speech emotion pattern recognition agent in mobile communication environment using fuzzy-SVM. Adv Soft Comput 40:419–430

Cowie R, Douglas-Cowie E, Tsapatsoulis N, Votsis G, Kollias S, Fellenz W, Taylor J (2001) Emotion recognition in human-computer interaction. IEEE Signal Process Mag 18(1):32–80

De Sá M, Carriço L (2009) Supporting end-user development of personalized mobile learning tools. In: Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 5613, Issue PART 4. LNCS, Portugal, pp 217–225

De Silva L, Miyasato T, Nakatsu R (1997) Facial emotion recognition using multimodal information. In: IEEE international conference on information, communications and signal processing (ICICS'97), pp 397–401

Du Boulay B (2000) Can we learn from ITSs?. In: Gauthier G, Frasson C, VanLehn K (eds) ITS 2000, LNCS 1839. Springer, Berlin, pp 9–17

Elliott C, Rickel J, Lester J (1999) Lifelike pedagogical agents and affective computing: an exploratory synthesis. In: Wooldridge MJ, Veloso M (eds) Artificial intelligence today, LNCS 1600. Springer, Berlin, pp 195–212

Farooq U, Shafer W, Rosson MB, Caroll JM (2002) M-education: bridging the gap of mobile and desktop computing. In: IEEE international workshop on wireless and mobile technologies in education (WMTE'02), pp 91−94

Feng J, Johnston M, Bangalore S (2011) Speech and multimodal interaction in mobile search. In: Proceedings of the 20th international conference companion on world wide Web, pp 293–294

Frohberg D, Göth C, Schwabe G (2009) Mobile learning projects – a critical analysis of the state of the art: original article. J Comput Assist Learn 25(4):307–331

Geven A, Tscheligi M, Noldus L (2009) Measuring mobile emotions: measuring the impossible? In: Proceeding of ACM international conference series. Article number 109

Hasebrook JP, Gremm M (1999) Multimedia for vocational guidance: effects of individualised testing, videos and photography on acceptance and recall. J Educ Multimedia Hypermedia 8(4):377–400

Huang TS, Chen LS, Tao H (1998) Bimodal emotion recognition by man and ma-chine. In: ATR workshop on virtual communication environments, Kyoto, Japan

Hürst W, Van Wezel C (2011) Multimodal interaction concepts for mobile augmented reality applications. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 6524, Issue PART 2. LNCS, pp 157–167

Hwang CL, Yoon K (1981) Multiple attribute decision making: methods and applications, vol 186. Springer, Berlin

Ketamo H (2003) An adaptive geometry game for handheld devices. Educ Technol Soc 6(1):83–95

Kondratova I (2009) Multimodal interaction for mobile learning. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 5615, Issue PART 2, LNCS, pp 327–334

Kuo Y-H, Huang Y-M (2009) MEAT: An authoring tool for generating adaptable learning resources. Educ Technol Soc 12(2):51–68

Lehner F, Nosekabel H (2002) The role of mobile devices in E-learning- first experiences with a wireless E-learning environment. In: IEEE international workshop on wireless and mobile technologies in education (WMTE'02), pp 103–106

Liao W, Zhang W, Zhu Z, Ji Q, Gray WD (2006) Toward a decision-theoretic framework for affect recognition and user assistance. Int J Hum Comput Stud 64:847–873

Lim MY, Aylett R (2007) Feel the difference: a guide with attitude!. Lecture notes in computer science, vol 4722. LNCS, pp 317–330

Mäntyjärvi J, Paternò F, Santoro C (2007) Incorporating tilt-based interaction in multimodal user interfaces for mobile devices. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 4385. LNCS, pp 230–244

Motiwalla LF (2007) Mobile learning: a framework and evaluation. Comput Educ 49(3):581–596

Motiwalla LF, Qin J (2007) Enhancing mobile learning using speech recognition technologies: a case study. In: Conference proceedings of 8th world congress on the management of e-business, WCMeB 2007, Article number 4285317

Moulin C, Giroux S, Pintus A, Sanna R (2002) Mobile lessons using geo-referenced data in e-learning. In: Gouarderes SA, Paraguacu F (eds) Intelligent tutoring systems 2002, vol 2363. LNCS, p 1004

Mueller W, Schaefer R, Bleul S (2004) Interactive multimodal user interfaces for mobile devices. In: Proceedings of the Hawaii international conference on system sciences, vol 37, 2004, Article number STMDI07, pp 4545–4554

Nielek R, Wierzbicki A (2010) Emotion aware mobile application. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics) vol 6422, Issue PART 2. LNAI pp 122–131

Oviatt S (2000) Multimodal system processing in mobile environments, UIST (User Interface Software and Technology). In: Proceedings of the ACM symposium, pp 21–30

Oviatt S (2003) User-modeling and evaluation of multimodal interfaces. In: Proceedings of the IEEE, pp 1457–1468

Oviatt S, Lunsford R (2005) Multimodal interfaces for cell phones and mobile technology. Int J Speech Technol 8(2):127–132

Pantic M, Rothkrantz LJM (2003) Toward an affect-sensitive multimodal human-computer interaction. In: Proceedings of the IEEE, vol 91, pp 1370–1390

Park Y-W, Lim C-Y, Nam T-J (2010) CheekTouch: an affective interaction technique while speaking on the mobile phone. In: Proceedings of conference on human factors in computing systems, pp 3241–3246

Pastor O, Gómez J, Insfrán E, Pelechano V (2001) The OO-Method approach for information systems modeling: from object-oriented conceptual modeling to automated programming. Inf Syst 26(7):507–534

Picard, RW (2003) Affective computing: challenges. Int J Human-Comput Stud 59(1–2):55–64

Platinum Technology Inc, Paradigm Plus: Round-Trip Engineering for JAVA, White Paper (1997)

Rational Software Corporation, Rational Rose User's Manual (1997)

Razak AA, Abidin MIZ, Komiya R (2008) Voice driven emotion recognizer mobile phone: proposal and evaluations. Int J Inf Technol Web Eng 3(1):53–69

Réhman SU, Liu L (2008) Vibrotactile emotions on a mobile phone. In: Proceedings of the 4th international conference on signal image technology and internet based systems, SITIS 2008. Article number 4725810, pp 239–243

Réhman SU, Liu L (2010) iFeeling: vibrotactile rendering of human emotions on mobile phones, lecture notes in computer science (including subseries lecture notes in artificial Intelligence and lecture notes in bioinformatics) vol 5960. LNCS, pp 1–20

Reis T, De Sá M, Carriço L (2008) Multimodal interaction: real context studies on mobile digital artefacts. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 5270. LNCS, pp 60–69

Rico J (2010) Evaluating the social acceptability of multimodal mobile interactions. In: Proceedings of conference on human factors in computing systems, 2010, pp 2887–2890
Salomon G (1990) Studying the flute and the orchestra: controlled vs. classroom research on computers. Int J Educ Res 14:521–532
Self J (1999) The defining characteristics of intelligent tutoring systems research: itss care Precisely. Int J Artif Intel Educ 10:350–364
Shieh C-K, Mac S-C, Chang T-C, Lai C-M (1996) An object-oriented approach to develop software fault-tolerant mechanisms for parallel programming systems. J Syst Softw 32(3):215–225
Sison R, Shimura M (1998) Student modelling and machine learning. Inter J Artif Intell Educ 9:128–158
Spika M (2010) Synchronizing multimodal user input information in a modular mobile software platform. In: Proceedings of the international symposium on consumer electronics, ISCE 2010, Article number 5522701
Turner M, Love S, Howell M (2008) Understanding emotions experienced when using a mobile phone in public: the social usability of mobile (cellular) telephones. Telematics Inform 25(3):201–215
Uzunboylu H, Cavus N, Ercag E (2009) Using mobile learning to increase environmental awareness. Comput Educ 52(2):381–389
Vainio T (2009) Exploring multimodal navigation aids for mobile users. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics), vol 5726, Issue PART 1, LNCS, pp 853–865
Vavoula G, Sharples M (2002) KleOS: a personal, mobile, knowledge and learning organisation system. In: IEEE international workshop on wireless and mobile technologies in education (WMTE'02), pp 152–155
Vincent J (2009) Affiliations, emotion and the mobile phone, Lect Notes Comput Sci 5641 LNAI:28−41
Virvou M (2002) A cognitive theory in an authoring tool for intelligent Tutoring systems. In: proceedings of IEEE international conference on systems man and cybernetics 2002 (SMC'02), vol 2, pp 410–415
Virvou M, Kabassi K (2001) F-SMILE: an intelligent multi-agent learning environment. In: proceedings of IEEE international conference on advanced learning technologies 2002 (ICALT'02)
Virvou M, Alepis E, Troussas C (2011) MMALL: multilingual mobile-assisted language learning. In: Proceedings of the 1st international symposium on business modeling and software design 2011—BMSD 2011, pp 129–135
Wang Y-S, Wu M-C, Wang H-Y (2009) Investigating the determinants and age and gender differences in the acceptance of mobile learning. Br J Educ Technol 40(1):92–118
Weber G, Brusilovski P (2001) ELM-ART: an adaptive versatile system for web-based instruction. Int J Artif Intell Educ 12:351–384
Welch M, Brownell K (2000) The development and evaluation of a multimedia course on educational collaboration. J Educ Multimedia Hypermedia 9(3):169–194
Wenger E. (1987) Artificial intelligence and tutoring systems. Morgan Kaufmann, Los Altos
Williamson J, Murray-Smith R, Hughes S (2007) Shoogle: excitatory multimodal interaction on mobile devices. In: Proceedings of conference on human factors in computing systems, 2007, pp 121–124
Yoon WJ, Cho YH, Park KS (2007) A study of speech emotion recognition and its application to mobile services. Lecture notes in computer science, vol 4611. LNCS, pp 758–766
Zeng Z, Tu J, Liu M, Huang T, Pianfetti B, Roth D, Levinson S (2007) Audio-visual affect recognition. IEEE Trans Multimedia 9:424–428
Zhan H-F, Deng H–J (2010) Study on a portable education administration assistant system. In: WRI international conference on communications and mobile computing, CMC 2010, vol 1, pp 555–558

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